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PRINCIPLES OF
Environmental Science
INQUIRY & APPLICATIONS
Third Edition

PRINCIPLES OF
Environmental Science

The McGraw-Hill Companies



Higher Education

PRINCIPLES OF ENVIRONMENTAL SCIENCE: INQUIRY AND APPLICATIONS
THIRD EDITION

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PREFACE

Can we learn to live sustainably on this planet, drawing only on nature's surplus and protecting the ecological processes on which life depends, while still providing a healthy, fulfilling life for everyone? This dilemma lies at the heart of environmental science.

Recent progress in environmental protection and improved human welfare gives us hope for reaching the goal of meeting urgent human needs while still preserving the earth's fragile life-support systems. Chlorofluorocarbon (CFC) releases into the atmosphere have decreased dramatically since the passage of the 1987 Montreal Protocol, for example, and destruction of UV-absorbing stratospheric ozone appears to be slowing. Similarly, clean air regulations have reduced sulfur dioxide emissions over North America by 31 percent over the past two decades. In many areas, acid precipitation, which threatened forests, crops, and aquatic ecosystems, has lessened. Currently, some 16.3 million km² (about 11 percent of the world land area) is protected in parks and nature preserves. Over the past 20 years, the average number of children born per woman worldwide has dropped nearly by half, and demographers predict that world population will stabilize by the middle of this century.

Still, many problems remain. Increasingly, we see evidence that human-caused global climate change is already underway. Biodiversity losses appear to be occurring at rates unmatched since the demise of the dinosaurs 65 million years ago. Hydrologists predict that, in a few decades, three-quarters of all humans will live in countries where freshwater supplies are inadequate to meet demand. Water wars could become a major source of conflict in the future. Bioconcentration of mercury and other toxins in food webs is a growing concern, not only in industrialized countries but even in remote areas where long-range transport of air pollutants can result in contamination problems. Currently, more than 800 million people are chronically undernourished, and more than 1.2 billion don't have enough money to provide the clean drinking water, shelter, medicine, sanitation, and education needed for a healthy, productive life.

Good science is needed to provide answers for solving these problems, but we also need an educated public that understands how science works and how to evaluate the difficult trade-offs we face. A broad-based environmental science course is an excellent way to teach a wide range of students about both scientific and

social issues. It can show how valid information is gathered and analyzed, as well as how to think critically and creatively about complex issues. Many instructors have asked for a textbook that gives students a strong foundation in the basic principles of environmental science. We understand and agree with that goal.

This book provides a solid foundation in scientific approaches to environmental problems and solutions. We integrate information from a wide range of disciplines from both the natural and social sciences. And we attempt to present a **balanced, objective perspective** that presents both sides of controversial issues. While much current environmental news is discouraging, we also present positive examples in which progress toward sustainability is being made. We also suggest ways that individuals can contribute to environmental protection and resource conservation. Although this book is suitable for nonscience majors, you will find that it isn't simplistic or condescending. The presentation, while condensed, remains sophisticated and discerning.

CONCISE AND AFFORDABLE

In recent years, environmental science textbooks have gotten bigger, more encyclopedic, and increasingly expensive. Both instructors and students call for a concise and affordable text. This book was written to fill that need. Rather than the 25 to 30 chapters found in most environmental science textbooks, we've limited this book to 15 chapters, or about 1 chapter per week for a typical semester course. The more concise presentation focuses on key principles, on scientific methods and ideas, and on life-long learning skills for students. We have also included enough case studies and current events to provide the real-world context for the themes discussed here. Additional case studies and current issues are also available on the book's website to help enrich your course's content. At the same time, the moderate size and price of this book should allow you to add supplementary materials to meet your individual teaching/learning objectives.

The outline of this book follows a topic sequence widely used in many environmental science textbooks and courses, but we know that many instructors choose to organize their courses around their own outlines. We've written each chapter in a way that doesn't assume that students have already read other chapters

in any particular order. If instructors prefer a different organization of course topics, chapters can be presented in any order that suits their course's needs.

ACTIVE LEARNING AND CRITICAL THINKING

Learning how scientists approach problems can help students develop habits of independent, orderly, and objective thought. But it takes active involvement to master these skills. Throughout this book, we encourage students to practice thinking for themselves. Data and interpretations aren't presented as immutable truths but, rather, as evidence to be examined and tested. We try to give a balanced view of controversial topics. Orderly, critical assessment of complex problems is a key part of **scientific literacy**, which is essential for understanding current environmental science. In every chapter, students are invited to practice **critical thinking** and to apply new ideas. We also include case studies demonstrating how scientists have thought about important environmental questions.

Because we think a discouraged student is unlikely to take positive action toward sustainability, we also strive to avoid "gloom and doom" or "shame and blame" attitudes. Instead, we adopt a thoughtful but cautiously optimistic view that will encourage readers to look for ways that we can solve problems and make our world a better place in which to live. In nearly every chapter, we include "What Can You Do?" boxes that give practical suggestions for things individuals can do to make a difference. Most chapters also have short applications boxes that invite readers to stop for a moment and practice using the principles they've learned.

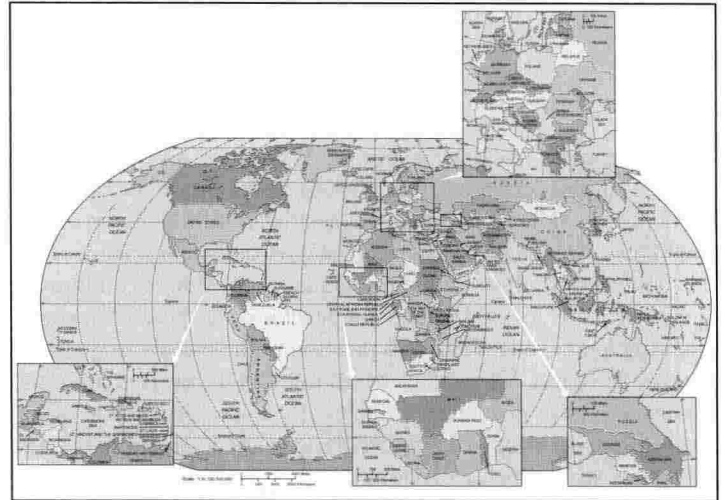
An introductory story at the beginning of each chapter illustrates an important current issue and relates it to practical environmental concerns. These stories also start the process of exploring how scientists study complex issues. In addition to these introductory stories, case studies and examples of how scientists investigate our environment appear periodically throughout the book to remind readers about the practical importance of these issues.

INTEGRATION AND SUSTAINABILITY

Environmental problems and their solutions occur at the intersection of natural systems and the human systems that manipulate the natural world. In this book, we present an **integrated approach** to physical sciences—biology, ecology, geology, air and water resources—and to human systems that affect nature—food and agriculture, population growth, urbanization, environmental health, resource economics, and policy. Although it is tempting to emphasize purely natural systems, we feel that students can never understand why coral reefs are threatened or why tropical forests are being cut down if they don't know something about the cultural, economic, and political forces that shape our decisions.

This integrated approach is essential if we are to work toward sustainable solutions in our environment. Throughout the book, we present **sustainability** as an ultimate goal for both preserving nature and improving the lives of people everywhere. Sus-

tainability implies that human well-being and environmental health need to be complementary, not contradictory, efforts. The goal of sustainability also requires a global view. We take a **global perspective** in this book because we believe that the most important and difficult environmental problems we now face involve worldwide resources and international institutions. To help students gain geographical literacy, we have included many maps and international case studies in this book, including a valuable set of world maps in the appendices.



CURRENCY

Throughout this book, we present up-to-date tables and graphs with the most current available data. We hope these data will give students an appreciation of the kinds of information available in environmental science. Among the sources we have called upon here are geographic information systems (GIS) data and maps, current census and population data, international news and data sources, and federal data-collection agencies.

This text has had the benefit of input from more than 400 researchers, professionals, and instructors who have reviewed this book or our larger text, *Environmental Science: A Global Concern*. These reviewers have helped us keep the text current and focused. We deeply appreciate their many helpful suggestions and comments.

WEB-ENHANCEMENT

The World Wide Web has become a vast and valuable resource for students. You can find a wealth of information there to update or supplement topics in environmental science. We incorporate this resource more fully in this text than in any other environmental science book currently available. Every chapter opens with a list of **web-based resources** that relate to and enrich the chapter contents. We have also placed further readings and extra case studies on the Web and have referenced these readings in the text. We encourage instructors to make use of these additional resources. At

the end of each chapter, a **web-based exercise** invites students to visit specific webpages and use the data found there to create graphs, make comparisons, or do some other practical analysis of real data. These aren't simplistic exercises that just ask the reader to look at a site and report on what it contains. Rather, we ask the student to explore these resources and use the information they find in pragmatic ways. Note that these exercises are just a beginning: instructors and students can modify or add to these exercises if they wish. One of our objectives in these exercises is simply to expose students to important data sources. Another objective in these exercises is to make students work with data, create graphs, map data, and experience some of the ways that scientists create and share information today.

LEARNING TOOLS

This book is intentionally written in a **lively, accessible style** and illustrated with nearly 400 full-color photographs and figures that help explain important concepts. We have also integrated a number of learning tools to help students gain an informed, thoughtful view of our environment:

- **“Investigating Our Environment” essays.** These examples give students some experience with tools and approaches scientists use to solve contemporary environmental problems. Each boxed essay shows how scientists work to solve complex environmental questions.



INVESTIGATING Our Environment

Using GIS to Protect Biodiversity

Investigating fragmentation, and many other biodiversity questions, requires information about the distribution of a species and its habitat. A researcher investigating grizzlies in Yellowstone, for example, needs to know where the bears are, where suitable habitat is, where sources of risk are (such as highways or towns), and where prey are abundant. Increasingly, all these maps are combined and analyzed using geographic information systems (GIS).

What is a GIS? It is software that makes maps from spatial data. Spatial data might show locations of animal observations, habitat boundaries, elevations and slopes, or other features. Land cover maps, showing the distribution of forests, lakes, farmlands, cities, and roads, help identify suitable habitat areas. By mapping all these features, scientists can investigate relationships among them.

You may have used a GIS: online mapping services, such as MapQuest, use digital data representing roads, cities, landmarks, and addresses to make maps on demand. While you might make a map showing the distance, direction, and driving routes to a destination, an ecologist might map animal locations, measure the size of habitat fragments, or monitor animal movements among habitat patches.

How does a GIS work? First it stores digital representations of features. Some representations are made up of fields of cells, as in a digital image. Imagine a digital picture of a daisy, for example: it is made up of a field of pixels (picture elements, or tiny squares). Some are coded white to represent petals; some are green to represent the stem and leaves. Now imagine a digital map of land cover. Some cells might be blue to represent water, some dark green to represent forest, some light green for grass, and some red for urban land uses. Another digital map might show different

types of soils: brown for organic-rich fertile soils, yellow for sandy soils, gray for moist wetland soils. Alternatively, a GIS can have data encoded as points, lines, or polygons: a lake would be represented by a polygon, a stream by a line, and a water quality sampling station as a point.

Once data are encoded digitally, they can be overlaid or combined. An analyst can overlay land cover and soils layers, then calculate the amount of forests that occur on sandy soils, or the amount of urban land uses that have taken over arable organic-rich soils. Fragmentation problems can be investigated: how many forest fragments are there; how big are they, and how far apart? How close are urban areas to the best habitat areas—and how soon might we expect urban expansion to intrude into those habitat areas? To investigate biodiversity, one might ask, how many species observations have occurred per habitat fragment? Once fragment size is calculated, how many species records are there per unit area? Do rare species occur only in the largest habitat fragments?

After analysis, a GIS makes maps to present data or results. Maps can be presented to the public for discussion, to policymakers for decisions, or to other researchers interested in similar problems.

GIS aids in studying many types of problems in many fields. Geographers, ecologists, urban planners, climatologists, sociologists, and many others are using maps and calculating measurements from digital data to gain insight into their research questions.



Gap analysis is an important example of using a geographic information system (GIS) for conserving biodiversity. Digital data help scientists quantify, analyze, and model environmental problems.

- **Study aids.** Each chapter opens with a list of objectives that summarize the main points of the chapter. These objectives are written in active terms that suggest to the student that it requires active involvement on their part to learn environmental science. Notice that, while some objectives call for simple, concrete thinking skills, others are deliberately

aimed at higher cognitive levels to encourage students to think reflectively, analytically, and critically. Although asking students to analyze, understand, explore, or question don't have simple, clear endpoints that can be measured objectively, we believe it's important to point out the need for higher-level thinking about complex issues. Every chapter ends with a summary of main points, a list of key terms, and review questions that help the student review material and prepare for tests.

- **Scientific thinking.** A more challenging, open-ended set of questions titled “Thinking Scientifically” encourages students to think more deeply and independently about issues and principles presented in the chapter. These questions make excellent starting points for discussion sections. They also could be used to practice for essay exams or might even serve as an essay exam themselves.
- **Statistics, graphs, and data.** Knowing that many students have little background in math, we've included special features on statistical methods and how they apply to environmental science, as well as discussion of how graphs can be used to present data. To give students practice in graphing, several end-of-chapter web exercises include graphing exercises.
- **Applications.** Because few of us learn effectively without an opportunity to actively apply new ideas, we have included application boxes. These boxes provide a break in reading the text and invite students to practice or apply skills they have just learned. In addition, “What Can You Do?” boxes in nearly every chapter suggest practical things that individuals can do to help improve environmental quality and resource conservation.



Developing a Sense for Where You Live

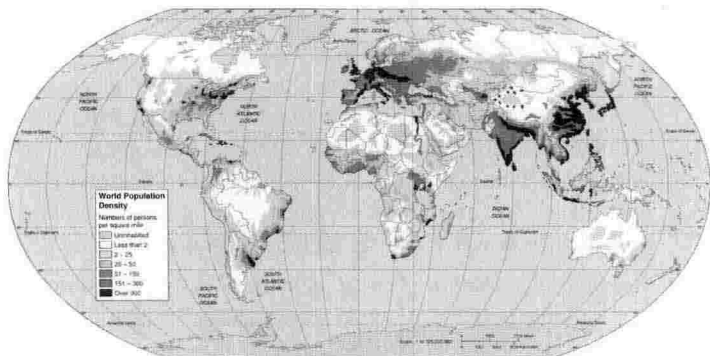
One of the first steps toward conserving biological diversity is to educate yourself. The more you know, the more you can share your knowledge—and skills—to help the natural world. Look for answers to questions such as these:

- What ecosystems and biological communities existed in your area before European settlement?
- What impact, if any, did indigenous people have on the flora and fauna of your area?
- What are the dominant species (besides humans) in your neighborhood? Where did they originate?
- How much rain falls in your region each year? Is precipitation seasonal? Is water a limiting factor for biological communities?
- What are the seasonal high and low temperatures where you live? How do native plants and animals adapt to seasonal variations?
- Is there a keystone species or group of species especially important in determining the structure and functions of your local ecosystems? What factors might threaten those keystone components?
- Where do your drinking water, food, and energy come from? What local and regional environmental impacts are caused by production, use, and disposal of those resources? Could you lessen those impacts by changing your sources or use patterns of resources?
- Is there a park or wildlife refuge near where you live? Does it contain any rare, threatened, or endangered species? What makes them rare, threatened, or endangered?
- Are there opportunities for volunteer work to improve your local environment, such as planting native species, cleaning up a river or lake, restoring a wetland, recycling trash, or helping maintain a refuge or park?

- **Web exercises.** The World Wide Web has become an extremely important source of current data, but many students know little about the kinds of information available or the agencies and organizations that produce it. Our web

exercises make use of current data and ask students to perform activities such as graphing data, comparing maps, and using live GIS sources to learn about environmental issues and information sources.

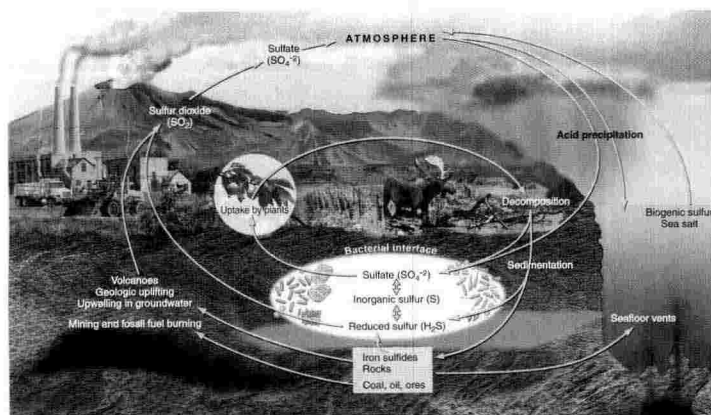
- *Maps and appendices.* The appendices include conversion factors for weights and measures in an easy-to-locate position on the inside back cover. A new and expanded set of maps serves as a reference for the whole book and should help students expand their geographical knowledge and global perspective. The glossary defines all key terms as well as other important vocabulary words. A list of further readings will be posted on the webpage, where it can be updated periodically.



NEW FEATURES IN THIS EDITION

Updated Art Program

We are fortunate to have a collection of beautiful, three-dimensional, photo-realistic drawings by Kandis Elliott, of the University of Wisconsin, that illustrate ecological cycles and relationships in a more realistic and recognizable style to help students understand important environmental principles. More than 50 new or revised graphs, drawings, and other graphics (about 200 in total) provide valuable information as well as making the text attractive and highly readable. Additional maps



have been added to give students an understanding of geography, including small place maps to locate major world biomes. In addition, 10 new tables allow readers to compare and understand data in greater depth than provided by straight text. A fold-out world map is included at the end of the book as additional reference for political and physical world regions.

New Photographs

We believe that students benefit from seeing photographs of people and nature in actual settings. For students who may rarely get outdoors and whose primary contact with the world around them is the computer screen or TV, photographs can add interest and authenticity to their study of environmental science. While other textbooks in this area have reduced or eliminated photographs from their texts, we continue to use high-quality photographs. Roughly half of our 406 figures are photographs, and approximately half of those are new for this edition. We are fortunate to have access to the outstanding photography of Dr. Barry Barker of Nova Southeastern University and David L. Hansen of the University of Minnesota Agricultural Experiment Station, whose works are prominently featured in this edition.

Updated Information

Much has happened in environmental science since the second edition of this text. Every chapter has been updated with new information.

- Chapter One has an entirely new section on current environmental conditions.
- Following reviewers' suggestions, we've moved the Periodic Table of Elements to the appendix, where it's still available for those who are interested but doesn't disrupt information flow for those who don't use it.
- In chapter 4, new data on human populations and recent advances in birth control have been added.
- Chapter 5 has undergone extensive reorganization, with a new section on marine ecosystems.
- The discussion of threats to biodiversity in chapter 5 also has been reorganized around E. O. Wilson's acronym HIPPO.
- In one of the most dramatic changes in environmental science in recent years, the WHO documents a shift in the most important health threats worldwide from infectious diseases to chronic conditions such as obesity, depression, trauma, and cardiovascular diseases once thought to be limited to the richest countries. As Western lifestyles spread to developing countries, however, the diseases of affluence have become the leading causes of death and morbidity nearly everywhere. Chapter 8 has been rewritten to reflect this new reality.
- Chapter 9 contains a wealth of new information on global climate change together with a discussion of clean air controversies in the United States.

- Chapter 10 incorporates updated data on water quality, water shortages, and water pollution, including the terrible problem of arsenic poisoning of groundwater in South Asia.
- The expert advice of Dr. John Pratt has guided revisions to chapters 11 and 12, and these chapters are strengthened and improved by his suggestions.

Many other chapters also have new data and features that we don't have room to detail here. Altogether, we believe you'll find this edition the most up-to-date of any textbook currently on the market.

GIS and Remote Sensing

Drawing on Mary Ann Cunningham's expertise in the areas of GIS, remote sensing, and biogeography, we have added several boxed readings to explain these important techniques and to show how they can be used in environmental science.

New Case Studies, Opening Stories, and Other Special Readings

Every chapter starts with an opening vignette, which presents a fascinating current environmental problem that illustrates the principles to be presented in the text. Interspersed throughout each chapter are other special features that show concrete application of theoretical knowledge. Ranging from controversy over dredging PCBs from the Hudson River to the threat of bioterrorism, these special readings also provide an opportunity to bring up current events and to make connections to real-life issues. Of the 30 special readings in the book, 16 are new to this edition, making the text thoroughly up-to-date and relevant.



CASE STUDY
FAMILY PLANNING IN IRAN

After the Islamic Revolution in 1979, Iran had one of the world's highest population growth rates. In spite of civil war, large-scale emigration, and economic austerity, the country surged from 34 million to 63 million in just 20 years. A crude birth rate of 43.4 per 1,000 people and a total fertility rate of 5.1 per woman during this time resulted in an annual population growth of 3.9 percent and a doubling time of less than 18 years. Religious authorities exhorted couples to have as many children as Allah would give them. Any mention of birth control or family planning (other than to have as many children as possible) was forbidden, and the marriage age for girls was dropped to 9 years old. When a devastating war with Iraq in the 1980s killed at least 1 million young soldiers, producing more children to rebuild the army became a civic as well as religious duty.

In the late 1990s, however, the Iranian government became aware of the costs of such rapid population growth. With religious moderates gaining greater political power, public policy changed abruptly. Now the Iranian government is spending millions of dollars to lower

birth rates. Couples must pass a national family planning course before they are allowed to marry. While it took a few years to convince people that this change will be long-lasting, most Iranian citizens are now eager for access to birth control information. Family planning classes are sought out both by engaged couples and those already married. A wide range of birth control methods are available. Implantable or injectable slow-release hormones, condoms, intrauterine devices (IUDs), pills, and male or female sterilization are free to all. Billboards, newspapers, television, and even water towers advertise this national program. Religious leaders have issued a *fatwa*, or command, that all faithful Muslims participate in family planning.

As a consequence, Iran has been remarkably successful in stemming its population growth. Between 1986 and 1996 the fertility rates for urban residents dropped almost by half, to less than three children per woman, and the crude birth rate dropped from 43 to 18 per 1,000 people. By 2000 the average annual growth rate had fallen to 1.4 percent. While the population is still increasing, another decade of such progress would bring the

country to a stable or even declining rate of growth.

Several societal changes have contributed to this rapid birth reduction. While the minimum marriage age has been returned to 15, couples are encouraged to wait until at least age 20 to begin their families. The educational benefits of concentrating the family resources on just one or two children are being promoted. Although women's roles are still highly restricted in the Islamic Republic, greater gender equity has given women more control over their reproductive lives. Access to modern, information-age jobs gives people an incentive to seek out education both for themselves and for their children.

The demographic transition hasn't spread to all levels of Iranian society, however. Rural families, ethnic minorities, and some urban poor still tend to have many children. Still, this example of how quickly both ideals of the perfect family size and information about modern birth control can spread through a society—even a highly religious, fundamentalist one—is encouraging for what might be accomplished worldwide in a surprisingly short time.

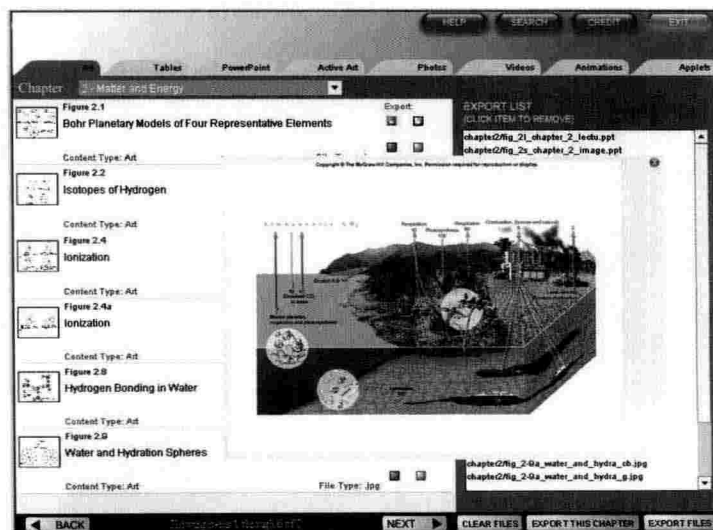
this database, so we've added a short list of suggested readings to each chapter to show important data sources and current directions in science.

LET US KNOW WHAT YOU THINK

We'd appreciate hearing from both students and instructors about where—and how—we could improve this text. You, the users, are the real test of whether we have accomplished our goal of presenting the principles of environmental science in an engaging and understandable way. Please let us know what you think. We value your comments and suggestions. Please send your recommendations to the Integrative Biology Division of McGraw-Hill, 2460 Kerper Blvd., Dubuque, IA, 52001.

USEFUL SUPPLEMENTS

- **Digital Content Manager (DCM) CD-ROM.** This multimedia collection of visual resources allows instructors to utilize artwork from the text in multiple formats to create customized classroom presentations, visually based tests and/or quizzes, dynamic course website content, and attractive printed support materials. The digital assets on this cross-platform CD-ROM are grouped within the following easy-to-use folders:
 - *Illustrations and photos.* All of the line drawings from the text and hundreds of photos are in ready-to-use digital files.
 - *PowerPoint lecture outline.* Ready-made presentations combine art from the text with customized, instructor-written lecture notes, covering all 15 chapters.
 - *Tables.* Every table that appears in the text is provided in electronic form.
 - *Active art.* These special art pieces consist of key images from the text that are converted to a format that allows instructors to break the art down into core elements and then group the various pieces and create customized



Suggested Readings

Our Online Learning Center website has an extensive list of more than 2,500 annotated citations to important environmental articles. We know, however, that few students take the time to investigate

images. This is especially helpful with difficult concepts; they can be presented step-by-step.

- **Animations.** Numerous full-color animations illustrating many different concepts covered in the study of environmental science are provided. The visual impact of motion will enhance classroom presentations and increase comprehension.
- **Additional photo library.** Over 400 full-color photographs *additional* to those already in the textbook are included in the Digital Content Manager. These photos are specific to environmental science topics, and are searchable by content.
- **Instructor's Testing and Resource CD-ROM.** This cross-platform CD-ROM provides a wealth of resources for the instructor. Supplements featured on this CD-ROM include lab activities, and a computerized test bank to quickly create customized exams. This user-friendly program allows instructors to search for questions by format, edit existing questions or add new ones, and scramble questions and answer keys for multiple versions of the same test. Other assets on the Instructor's Testing and Resource CD-ROM are grouped within easy-to-use folders.
- **Transparencies.** A set of 100 transparencies is available to users of the text. These acetates include key figures from the text, including new art from this edition.
- **Interactive World Issues CD-ROM.** This CD explores environmental issues that affect various geographic regions. For example, you'll visit Oregon and investigate water rights of the Columbia River. Listen to Native Americans whose living depends on salmon fishing and then to the farmers who need water to irrigate their crops. Additional case studies discuss migration in Mexico, apartheid in South Africa, population issues in China, and farming in urban Chicago.
- **Online Learning Center.** (<http://www.mhhe.com/cunningham3e>). This comprehensive website offers numerous resources for both students and instructors.

Student Resources—Everything you need in one place

- Practice quizzing
- How-to study tips
- Web links to related topics
- Web exercises
- Guide to electronic research
- Regional perspectives (case studies)
- Environmental issues world map
- Key term flashcards
- How to write a paper
- How to contact your elected officials
- Further readings
- Metric equivalents and conversion tables
- Career information
- Access Science offering the advantage of an online, interactive encyclopedia

Instructor Resources—in addition to all of the above, you'll receive:

- Supplements resource chart for each chapter
- Answers to web exercises
- Additional case studies
- Answers to critical thinking questions
- PageOut (create your own course website)

- **New!! Exploring Environmental Solutions with GIS.** This short book provides exercises for students and instructors who are new to GIS but are familiar with the Windows operating system. The exercises focus on improving analyt-

ical skills, understanding spatial relationships, and understanding the nature and structure of environmental data. Because the software used is distributed free of charge, this text is appropriate for courses and schools that are not yet ready to commit to the expense and time involved in acquiring other GIS packages.

RELATED TITLES OF INTEREST

1. *Exploring Environmental Solutions with GIS* (includes CD-ROM) (0-07-297744-2) by Stewart, Schneiderman, Cunningham, and Gold.
2. *Field and Laboratory Activities Manual*, 7th ed. (0-07-290913-7) by Enger and Smith.
3. *Interactive World Issues: Of Place and Planet CD-ROM* (0-07-255648-X), Cambridge Studios.
4. *Annual Editions: Environment 04/05* (0-07-286147-9). Editor: John L. Allen.
5. *Taking Sides: Clashing Views on Controversial Environmental Issues*, revised 10th ed. (0-07-293317-8). Editors: Thomas Easton, Theodore D. Goldfarb.
6. *Sources: Notable Selections in Environmental Studies*, 2nd ed. (0-07-303186-0). Editor: Theodore D. Goldfarb.
7. *The Dushkin Student Atlas of Environmental Issues* (0-697-36520-4). Editor: John Allen. University of Connecticut.

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We're indebted to all the instructors who have reviewed the manuscript and made helpful suggestions, corrections, and recommendations for improving this book. Space does not permit inclusion of all the excellent ideas that were provided, but we will continue to do our best to incorporate the ideas that reviewers have given us. In addition, all of us owe a big debt to the many scholars whose work forms the basis of our understanding of environmental science. We stand on the shoulders of giants. If errors persist in spite of our best efforts to root them out, we accept responsibility.

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CONTENTS IN BRIEF

- | | | |
|----|--|-----|
| 1 | Understanding Our Environment | 1 |
| 2 | Principles of Ecology: Matter, Energy, and Life | 25 |
| 3 | Populations, Communities, and Species Interaction | 48 |
| 4 | Human Populations | 74 |
| 5 | Biomes and Biodiversity | 95 |
| 6 | Environmental Conservation: Forests, Grasslands, Parks, and Nature Preserves | 124 |
| 7 | Food and Agriculture | 149 |
| 8 | Environmental Health and Toxicology | 175 |
| 9 | Air: Climate and Pollution | 198 |
| 10 | Water: Resources and Pollution | 229 |
| 11 | Environmental Geology and Earth Resources | 259 |
| 12 | Energy | 278 |
| 13 | Solid and Hazardous Waste | 306 |
| 14 | Sustainability and Human Development | 327 |
| 15 | Environmental Science and Policy | 352 |



CONTENTS

Preface xi

Chapter 1 Understanding Our Environment 1

- Objectives 1
- Learning Online 1
- Dredging the Hudson River 2
- Understanding Our Environment** 3
 - A Marvelous Planet 3
 - What Is Environmental Science? 4
- Science As a Way of Knowing** 4
 - Cooperation and Insight in Science 5
 - Scientific Design 6
 - Deductive and Inductive Reasoning 6
 - Hypotheses and Theories 6
 - Modeling and Natural Experiments 7
 - Statistics and Probability 8
- Investigating Our Environment** What Are Statistics, and Why Are They Important? 8
 - Paradigms and Scientific Consensus 9
 - Pseudoscience and Baloney Detection 10
- Thinking About Thinking** 10
 - Approaches to Knowledge and Meaning 11
 - Applying Critical Thinking 12
- Investigating Our Environment**
 - A Skeptical Environmentalist? 12
 - Some Clues for “Unpacking” an Argument 13
 - Using Critical Thinking 13
- A Brief History of Conservation and Environmentalism** 14
 - Historic Roots of Nature Protection 14
 - Pragmatic Resource Conservation 14
 - Moral and Aesthetic Nature Preservation 15
 - Modern Environmentalism 15
 - Global Concerns 16
- Current Environmental Conditions** 16
 - Signs of Hope 18
- Human Dimensions of Environmental Science** 19
 - Rich and Poor Countries 19
 - A Fair Share of Resources? 20
 - Sustainability 21
 - Indigenous Peoples 21

Chapter 2 Principles of Ecology: Matter, Energy, and Life 25

- Objectives 25
- Learning Online 25
- Measuring Energy Flows in Cedar Bog Lake 26
- Principles of Matter and Energy** 26
 - What Is Matter? 27
 - What Is Energy? 27
 - Thermodynamics and Energy Transfers 28
- The Building Blocks of Earth and Life** 28
 - Atoms, Molecules, and Compounds 28
 - Chemical Reactions 29
 - Acids and Bases 30
 - Organic Compounds 31
 - Cells: The Fundamental Units of Life 31
 - The Miracle of Water 32
- Sunlight: Energy for Life** 33
 - How Does Photosynthesis Capture Energy? 33
- Investigating Our Environment** Remote Sensing, Photosynthesis, and Material Cycles 35
- Energy and Matter in the Environment** 36
 - Food Chains, Food Webs, and Trophic Levels 36
 - Ecological Pyramids 38
- Biogeochemical Cycles and Life Processes** 38
 - The Hydrologic Cycle 38
 - The Carbon Cycle 39
 - The Nitrogen Cycle 40
 - The Phosphorus Cycle 43
 - The Sulfur Cycle 43
- Investigating Our Environment** Environmental Chemistry of Phosphorus 44

Chapter 3 Populations, Communities, and Species Interaction 48

- Objectives 48
- Learning Online 48
- Darwin and the Theory of Evolution 49
- Who Lives Where, and Why?** 50
 - Critical Factors and Tolerance Limits 50

Evolution: Natural Selection and Adaptation 51
Speciation 51
The Taxonomic Naming System 53
The Ecological Niche 53
What Are Weedy Species? 54

Species Interactions 55

Predation 55
Competition 56
Symbiosis 57
Defensive Mechanisms 57
Keystone Species 58

Population Dynamics 59

Population Growth 59
Boom and Bust Population Cycles 60
Growth to a Stable Population 60
Limiting Factors 61
K-adapted and r-adapted Species 61

Community Properties 62

Productivity 62
Abundance and Diversity 63

What Can You Do? Developing a Sense for Where You Live 64

Complexity, Resilience, and Stability 64
Community Structure 64

Case Study Biodiversity and Stability 66

Edges and Boundaries 67

Communities in Transition 68

Ecological Succession 68
Climax Communities or Individualistic Succession? 69
Introduced Species and Community Change 70

Chapter 4 Human Populations 74

Objectives 74

Learning Online 74

A Billion People and Growing 75

Population Growth 75

Human Population History 76
Population Doubling Times 76

Limits to Growth: Some Opposing Views 77

Malthusian Checks on Population 77
Malthus and Marx Today 78
Can Technology Make the World
More Habitable? 78
Could More People Be Beneficial? 79

Human Demography 79

How Many of Us Are There? 79

Investigating Our Environment Interpreting Graphs 80

Fertility and Birth Rates 81
Mortality and Death Rates 82
Life Span and Life Expectancy 82
Living Longer: Demographic Implications 83

Population Growth: Opposing Factors 84

Pronatalist Pressures 84
Birth Reduction Pressures 85

Demographic Transition 86

Development and Population 86
An Optimistic View 87

A Pessimistic View 87
A Social Justice View 87
Infant Mortality and Women's Rights 87

Family Planning and Fertility Control 88

Case Study Family Planning in Iran 89

Traditional Fertility Control 89
Current Birth Control Methods 89
New Developments in Birth Control 90

The Future of Human Populations 91

Chapter 5 Biomes and Biodiversity 95

Objectives 95

Learning Online 95

Coral Reefs Threatened 96

Terrestrial Biomes 96

Deserts 97
Grasslands: Prairies and Savannas 99
Tundra 99
Conifer Forests 100
Broad-Leaved Deciduous Forests 101
Mediterranean/Chaparral/Thorn Scrub 101
Tropical Moist Forests 102
Tropical Seasonal Forests 102

Marine Ecosystems 103

The Open Ocean 104
Coastal Regions: Reefs, Estuaries, Shoals,
and Mangroves 104
Tidal Environments and Barrier Islands 105

Freshwater Ecosystems 106

Lakes 106
Wetlands 106
Streams and Rivers 107

Biodiversity 107

How Many Species Are There? 107
Biodiversity Hot Spots 108

How Do We Benefit From Biodiversity? 108

Food 108
Drugs and Medicines 109
Ecological Benefits 109
Aesthetic and Cultural Benefits 109

What Threatens Biodiversity? 110

Natural Causes of Extinction 110

Human-Caused Reductions in Biodiversity 110

Habitat Destruction 111
Fragmentation 111
Invasive Species 112

Investigating Our Environment Using GIS to Protect Biodiversity 113

Pollution 114
Population 115
Overharvesting 115
Commercial Products and Live Specimens 116
Predator and Pest Control 117

Endangered Species Management And Biodiversity

Protection 117

Hunting and Fishing Laws 117

What Can You Do? Don't Buy Endangered Species Products	117
The Endangered Species Act	118
Recovery Plans	118
Reauthorizing the Endangered Species Act	120
Habitat Protection	120
International Wildlife Treaties	121

Chapter 6 Environmental Conservation: Forests, Grasslands, Parks, and Nature Preserves 124

Objectives	124
Learning Online	124
Protecting Forests to Preserve Rain	125
World Forests	126
Forest Distribution	126
Forest Products	127
Tropical Forests	128
Temperate Forests	130
What Can You Do? Lowering Your Forest Impacts	130
Investigating Our Environment Forest Thinning and Salvage	
Logging	133
Rangelands	134
Range Management	134
Rangelands in the United States	135
New Approaches to Ranching	135
Parks and Nature Preserves	136
North American Parks	136
Park Problems	137
Wildlife Issues	138
Parks as Ecosystems	138
Case Study Reintroducing Wolves to Yellowstone	139
World Parks And Preserves	140
Marine Preserves	141
Protecting Natural Heritage	141
Size and Design of Nature Preserves	141
Conservation and Economic Development	142
Indigenous Communities and Biosphere Reserves	143
What Can You Do? Being a Responsible Ecotourist	144
Wilderness Areas	144
Wildlife Refuges	145
International Wildlife Preserves	145

Chapter 7 Food and Agriculture 149

Objectives	149
Learning Online	149
Golden Rice	150
Food and Nutrition	151
Chronic Hunger and Food Security	151
Famines and Acute Food Shortages	152
Malnutrition and Obesity	153
Eating a Balanced Diet	154
Major Food Sources	155
Major Crops	155
Meat and Dairy	155
Seafood	157

Soil: A Renewable Resource 157

Soil Organisms	158
Soil Profiles	159
Soil Types	159

Ways We Use and Abuse Soil 159

Land Resources	159
Land Degradation	160
Erosion: The Nature of the Problem	161
Mechanisms of Erosion	161
Erosion Hot Spots	163

Other Agricultural Resources 163

Water	163
Fertilizer	163
Energy	164
Pest Control	164

New Crops and Genetic Engineering 165

The Green Revolution	165
----------------------	-----

What Can You Do? Reducing the Pesticides in Your Food 165

Genetic Engineering	166
Pest Resistance and Weed Control	166
Is Genetic Engineering Safe?	167

Sustainable Agriculture 168

Soil Conservation	168
Managing Topography	168
Providing Groundcover	169
Reduced Tillage	169

Case Study Shade-Grown Coffee and Cocoa 170

Low-Input Sustainable Agriculture	171
-----------------------------------	-----

Chapter 8 Environmental Health and Toxicology 175

Objectives	175
Learning Online	175
The Cough Heard Round the World	176
Environmental Health	176
Global Disease Burden	176
Emergent and Infectious Diseases	178
Funding Health Care	180
Ecological Diseases	180
Antibiotic and Pesticide Resistance	181
Diet	182

Toxicology 182

What Can You Do? Tips for Staying Healthy 183

Endocrine Hormone Disruptors	185
------------------------------	-----

Movement, Distribution, and Fate of Toxins 186

Solubility and Mobility	186
Exposure and Susceptibility	186
Bioaccumulation and Biomagnification	187
Persistence	187

What Do You Think? Children's Health 188

Chemical Interactions	189
-----------------------	-----

Mechanisms for Minimizing Toxic Effects 189

Metabolic Degradation and Excretion	189
Repair Mechanisms	190

Measuring Toxicity 190

Animal Testing	190
Toxicity Ratings	191
Acute versus Chronic Doses and Effects	191
Detection Limits	192

Risk Assessment and Acceptance	192
Understanding Risks	193
Accepting Risks	193
Establishing Public Policy	194

Chapter 9 Air: Climate and Pollution 198

Objectives	198
Learning Online	198
What's Happening to Our Weather?	199
The Atmosphere and Climate	199
Energy and the "Greenhouse Effect"	200
Convection and Atmospheric Pressure	201
Why Does It Rain?	202
The Coriolis Effect and Jet Streams	203
Ocean Currents	204
Seasonal Winds and Monsoons	204
Climate Change	205
El Niño/Southern Oscillation	206
Human-Caused Global Climate Change	207
Climate Skeptics	207
Sources of Greenhouse Gases	207
What Do You Think? Science and Uncertainty in Climate Change	208
Current Evidence of Climate Change	209
Winners and Losers	210
Investigating Our Environment Satellite Images	211
International Climate Negotiations	212
Controlling Greenhouse Emissions	212
Climate and Air Pollution	213
Major Kinds of Pollutants	214
Sources and Problems of Major Pollutants	215
Indoor Air Pollution	216
Interactions Between Climate Processes and Air Pollution	217
Long-Range Transport	217
Stratospheric Ozone Depletion	217
Signs of Progress	219
Urban Climates	219
Effects of Air Pollution	220
Human Health	220
Plant Pathology	220
Visibility Reduction	221
Acid Deposition	221
Air Pollution Control	222
Reducing Production	222
Clean Air Legislation	223
Clear Skies	224
Current Conditions and Future Prospects	225
Air Pollution in Developing Countries	225
Signs of Hope	225

Chapter 10 Water: Resources and Pollution 229

Objectives	229
Learning Online	229
Sharing the Chattahoochee	230

Water Resources	230
Where Does Our Water Come From?	231
Major Water Compartments	232
Groundwater	232
Rivers, Lakes, and Wetlands	233
The Atmosphere	234

Water Availability and Use	234
Water-Rich and Water-Poor Countries	234
Water Use	235
Quantities of Water Used	235

Freshwater Shortages	236
A Precious Resource	236
Depleting Groundwater	236
Can We Increase Water Supplies?	237
Dams, Reservoirs, and Canals	237

Case Study Water Wars on the Klamath	238
Price Mechanisms and Water Policy	239

Water Management and Conservation	240
You Can Make a Difference:	
Domestic Conservation	240
Signs of Progress	241

What Can You Do? Saving Water and Preventing Pollution	241
---	-----

Water Pollution	241
Point and Nonpoint Source Pollution	241
Biological Pollution	242
Inorganic Pollutants	245
Organic Chemicals	245

Case Study Arsenic in Drinking Water	246
Sediment and Thermal Pollution	246

Water Quality Today	247
Surface Waters in the United States and Canada	247
Surface Waters in Other Countries	249
Ocean Pollution	251

Pollution Control	252
Nonpoint Sources and Land Management	252
Sewage Treatment	252
Remediation	254

Water Legislation	255
The Clean Water Act	255

Chapter 11 Environmental Geology and Earth Resources 259

Objectives	259
Learning Online	259
Radioactive Waste Disposal at Yucca Mountain	260
A Dynamic Planet	261
A Layered Sphere	261
Tectonic Processes and Shifting Continents	261
Minerals and Rocks	262
Rock Types and How They Are Formed	262
Weathering and Sedimentation	264
Economic Geology and Mineralogy	265
Metals	265
Nonmetal Mineral Resources	265

Fuels: Oil, Coal, and Uranium 266

Environmental Effects of Resource Extraction 267

Mining 267

What Can You Do? Coal-Bed Methane 268

Processing 269

Conserving Geologic Resources 270

Recycling 270

Steel and Iron Recycling: Minimills 270

Substituting New Materials for Old 271

Geologic Hazards 271

Earthquakes 271

Volcanoes 272

Floods 273

Erosion 274

Chapter 12 Energy 278

Objectives 278

Learning Online 278

Sea Power 279

Energy Sources and Uses 279

Current Energy Sources 280

Per Capita Consumption 280

How We Use Energy 280

Fossil Fuels 282

Coal 282

Oil 283

Oil Shales and Tar Sands 284

Natural Gas 285

Nuclear Power 285

How Do Nuclear Reactors Work? 286

Nuclear Reactor Design 286

Nuclear Wastes 287

Energy Conservation 288

Using Energy More Efficiently 288

What Can You Do? Some Things You Can Do to Save Energy 289

Cogeneration 290

What Do You Think? Hybrid Automobile Engines 290

Solar Energy 291

Passive Solar Heat 291

Active Solar Heat 291

High-Temperature Solar Energy 292

Photovoltaic Energy 293

Transporting and Storing Electrical Energy 294

Promoting Renewable Energy 295

Fuel Cells 295

Biomass 296

Fuelwood Crisis

in Less-Developed Countries 296

Dung and Methane as Fuels 297

Fuels from Biomass 298

Energy From the Earth's Forces 298

Hydropower 298

Wind Energy 299

Geothermal, Tidal, and Wave Energy 301

What's Our Energy Future? 302

Chapter 13 Solid and Hazardous Waste 306

Objectives 306

Learning Online 306

Garbology: The Science of Trash 307

Waste 307

The Waste Stream 308

Waste Disposal Methods 308

Open Dumps 308

Ocean Dumping 309

Landfills 309

Exporting Waste 311

Incineration and Resource Recovery 311

Investigating Our Environment Environmental Justice 312

Shrinking the Waste Stream 313

Recycling 313

Composting 315

Energy from Waste 316

Demanufacturing 316

Reuse 316

Producing Less Waste 317

What Can You Do? Reducing Waste 318

Hazardous and Toxic Wastes 318

What Is Hazardous Waste? 318

Hazardous Waste Disposal 319

Options for Hazardous Waste Management 322

Investigating Our Environment Bioremediation 323

Chapter 14 Sustainability and Human Development 327

Objectives 327

Learning Online 327

Curitiba: An Environmental Showcase 328

Sustainability and Resources 328

Sustainable Development 329

Can Development Be Sustainable? 329

Resources in Classical Economics 329

Neoclassical Economics 330

Ecological Economics 330

Scarcity and Limits to Growth 332

Communal Property and the Tragedy
of the Commons 333

Cost-Benefit Analysis and Natural Resource Accounting 333

Accounting for Nonmonetary Resources 334

Measuring Real Progress 334

Internal and External Costs 335

Trade and Development 336

International Trade 336

International Development

and the World Bank 336

Microlending 336

Green Business and Green Design 337

Design for the Environment 337

Jobs and the Environment 338

What Can You Do? Personally Responsible Consumerism 338